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TRANSLATION FROM JAPANESE

(19) JAPANESE PATENT OFFICE (JP)

(11) Unexamined Patent Application (Kokai) No. **61-288154**

(12) Unexamined Patent Gazette (A)

(51) Int. Cl.[4]:	Identification Symbol:	JPO File No.:
G01N 30/60		7621-2G
B01D 15/08		

(43) Disclosure Date: Dec. 18, 1986

Request for Examination: Not filed

Number of Inventions: 1 (3 pages total [in original])

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(54) Title of the Invention: **Gas chromatography**

(21) Application No. 60-129394

(22) Filing Date: Jun. 14, 1985

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SPECIFICATION

1. **Title of the Invention**

Gas chromatography

2. **Claims**

A gas chromatography[1] characterized in that wafer-like ceramic heaters and ceramic substrates having a groove on one or both faces thereof are laminated in sandwich configuration; there being provided holes communicating with the grooves in said ceramic substrates.

3. **Detailed Description of the Invention**

<Field of Industrial Utilization>

The present invention relates to a structure for a gas chromatography column, and relates to a miniature, lightweight gas chromatography incorporating a heater portion as a thermostatic chamber.

<Prior Art>

Conventional gas chromatography can be broadly divided into the following five sections:

(1) flow adjustment section

(2) column

(3) sample injection section

(4) thermostatic chamber

(5) detector section

These sections are all constituted as individual components which are assembled together. Column designs include:

(1) those in which packing combined with the liquid phase is introduced into a metal pipe; and

(2) those in which the inside face of a quartz capillary [column] is coated with the liquid phase. To date there has been a gradual shift towards (2), owing to advantages in terms of precision, speed of analysis, and space.

<Problems the Invention Is Intended to Solve>

However, the conventional devices described above are bulky, making them difficult to move about; and since metal pipes or quartz capillary tend to bend easily (if a capillary should bend, the gas passage may become blocked), considerable care in handling is required.

<Means for Solving the Problems>

With the foregoing in view, the invention has as an object to reduce the size [of the unit] by forming the capillary and thermostatic chamber as an integrated unit, and to simplify handling by forming the capillary on a ceramic substrate; and features wafer-like ceramic heaters and ceramic substrates having a groove on one or both faces thereof laminated in sandwich configuration, there being provided holes communicating with the grooves in said ceramic substrates.

<Operation>

Ceramic heaters and ceramic substrates are laminated together with grooves formed on the ceramic substrates communicating, whereby it is possible to form a high-density, extended channel within [an assembly of relatively] small volume, so that sample gas flowing through the channel is heated to constant temperature to separate components for analysis.

<Examples>

Figs. 1(a) and (b) depict an embodiment of the invention, wherein (a) is a partly sectional perspective view of gas chromatography herein and (b) is a perspective view of ceramic heaters and ceramic substrates prior to lamination. In Figs. 1(a) and (b), 1a, 1b 1c denote ceramic substrates, for example, of square configuration 2 mm thick and about 50 mm per side. On one face of each ceramic substrate there is formed a spiral groove 2. The groove may be produced, for example, by etching, or by embedding combustible plastic wire into the malleable, unfired ceramic, and then firing the material to eliminate the plastic, using the cavity left behind by the eliminated plastic.

3a, 3b, 3c denote ceramic heaters arranged in sandwich configuration between ceramic substrates. As shown in Fig. 1(b), the groove formed in the ceramic substrate

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[1] [Translators Note: The author apparently understands chromatography (Jp. "kuromatogurafi") to mean

may, for example, start in area (a) in proximity to an outside edge of ceramic substrate 1c, proceeding in spiral fashion to the center portion of the ceramic substrate, where it passes through the center portion of the ceramic heater 3b arranged above this ceramic substrate, and communicates with the center portion of ceramic substrate 1b. The spiral groove formed in ceramic substrate 1b extends towards the outside edges to reach area (b). [The channel] then passes through a through-hole (c) formed in ceramic heater 3a at a location above area (b), [and communicates with] a groove in ceramic substrate 1a extending from an outside edge (d) towards the center portion of the ceramic substrate to reach area (e).

By laminating the ceramic substrates and ceramic heaters in sandwich configuration these grooves form a unified groove (hereinbelow termed "column"). The column is not limited to the spiral configuration depicted in this embodiment, and may instead be formed in an array, the important point being to produce maximum length per unit of area. The inside wall of the column is coated with liquid phase using techniques known in the art.

4a -4c denote component mounting plates functioning also as heat insulators, and consisting of ceramic wafers, for example; these are arranged enclosing the ceramic heaters 3a -3d and ceramic substrates 1a -1c. To the component mounting plates are integrally fixed a piezoelectric pump 7 for injecting sample gas via a sample gas injection line 6; a piezoelectric valve 8; and a sensor 9 having an outlet line 10. 11a, 11b are thick films formed on ceramic plates as heat insulators; these constitute electronic circuits necessary in gas chromatography.

In the above arrangement, a sample gas is injected into one end of the column by piezoelectric pump 7 and piezoelectric valve 8, and passes through the column while being heated to predetermined temperature. The time that the sample passing through the column in present in the liquid layer [sic; phase?], i.e., the retention time, assumes a value characteristic of the sample and separates into respective components[2]. The separated components are detected by sensor 9 and exit though the outlet line.

"chromatograph" (Jp. "kuromatogurafu").]

[2] [Translators Note: The author may have intended to say that the sample separates into components, each of which has a characteristic retention time.]

The ceramic heaters used may be selected appropriately with regard to measuring conditions of the sample gas, and ceramic heater temperature controlled by embedding a temperature sensor at a suitable location in the gas chromatography.

<Effects of the Invention>

According to the invention described in detail hereinabove together with an embodiment, there is now provided a miniature, lightweight solid state gas chromatography.

4. Brief Description of the Drawings

The drawing depicts an embodiment of the invention wherein (a) is a partly sectional perspective view of gas chromatography herein and (b) is a perspective view of ceramic heaters and ceramic substrates prior to lamination.

1a -1c ... ceramic substrates, 2 ... groove, 3a -3d ... ceramic heaters, 4a -4d ... component mounting plates, 6 ... sample gas injection line, 7 ... piezoelectric pump, 8 ... piezoelectric element valve, 9 ... gas sensor, 10 ... outlet line

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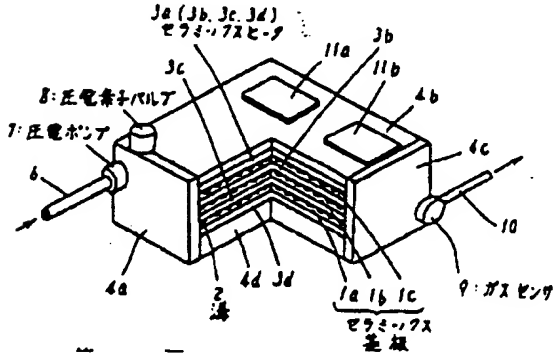
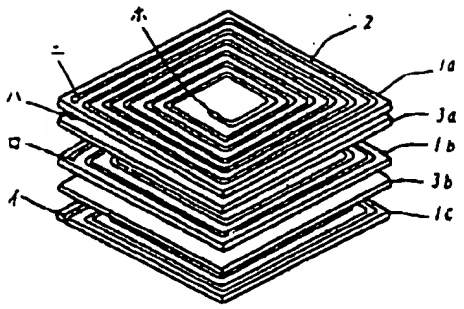
Fig. 1(a)



[1a 1b 1c ceramic substrates, 2 groove, 3a (3b, 3c, 3d) ceramic heater, 7 piezoelectric pump, 8 piezoelectric element valve, 9 gas sensor]

Fig. 1(b)



Procedural Amendment (Formal)

Oct. 8, 1987

To the Patent Office Commissioner

1. Designation of Case

   Patent Application 60-129394

2. Title of the Invention

   Gas chromatography

3. Amendant

   Relationship to case Applicant

   YOKOGAWA ELECTRIC CORPORATION

4. Agent

   OZAWA Shinsuke, Patent Attorney

5. Date of Invitation to Amend

   Sep. 27, 1987

6. Object of amendment

   Brief Description of the Drawings

7. Description of amendment

   "The drawing [depicts an embodiment of] the invention ..." is corrected to "Figs. 1(a) and (b) drawing [depict an embodiment of] the invention ..."

SF1082695v1

17. A method for making a multilayered micro-gas chromatograph device, said method comprising the steps of:

texturing a plurality of green-sheet layers in a predetermined pattern, said green-sheet layers including particles selected from the group consisting of ceramic particles, glass particles, and glass-ceramic particles, said predetermined pattern defining a micro-gas chromatograph column;

applying a first thick-film paste to at least a portion of said predetermined pattern in said green-sheet layers; and

sintering said green-sheet layers together at a predetermined temperature for a predetermined amount of time to form a substantially monolithic structure, said substantially monolithic structure having said micro-gas chromatograph column defined therein and a porous plug disposed in said micro-gas chromatograph column.

18. The method of claim 17, wherein said first thick film paste contains particles selected from the group consisting of alumina particles and glass particles.

19. The method of claim 17, further comprising the step of adding a stationary phase to said micro-gas chromatograph column so that at least a portion of said stationary phase is disposed in the pores of said porous plug.

20. The method of claim 17, wherein said micro-gas chromatograph column includes an exit channel, further comprising the step of applying a second thick-film

paste to a surface of one of said green-sheet layers to define a resistor disposed in said exit channel.

21. The method of claim 17, wherein said micro-gas chromatograph column includes a plurality of planar column sections, each one of said planar column sections being defined by a channel formed into one of said green-sheet layers.

22. The method of claim 21, further comprising the step of applying a third thick-film paste to a surface of one of said green-sheet layers to define a heater, said heater being disposed for raising the temperature of one of said planar column sections with respect to the other planar column sections.